DOCUMENT RESUME

ED 091 175 SE 017 512

TITLE	Science Safety Grades K-12. Curriculum Bulletin, 1971-72, Series, No. 7
INSTITUTION	New York City Board of Education, Brooklyn, N.Y. Bureau of Curriculum Development.
PUB DATE	72
NOTE	55p.
AVAILABLE FROM	New York Board of Education, Publications Sales Office, 110 Livingston Street, Brooklyn, New York 11201 ($1.00)
EDRS PRICE	MF-$0.75 HC Not Available from EDRS. PLUS POSTAGE
DESCRIPTORS	*Accident Prevention; Bulletins; Elementary School Science; Health; *Safety; *Safety Education; *Science Education; Secondary School Science
IDENTIFIERS	New York City

ABSTRACT

This bulletin includes general directions for assistant principals, science teachers, laboratory specialists, and pupils pertaining to science laboratory safety. A list of hazards and precautions is presented. Also included is a list of chemicals considered dangerous by the New York Fire Department. (DJH)

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ED 091173

Science Safety

Grades K-12

EMERGENCY NUMBERS

Ambulance	911
Doctor (local or school)	write in number
Doctor (when unable to reach local doctor)	
Manhattan	879-1000
Brooklyn	711-8800
Queens	268-7300
Bronx	328-1000
Richmond	987-3377
Fire	911
Gas	
Manhattan	679-6700
Brooklyn	643-4050
Queens	643-4050
Bronx	679-6700
Richmond	643-4050
Poison Control	340-4494
Police	911
Water Emergency Service	966-7500

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ED 091173

CURRICULUM BULLETIN • 1971-72 • SERIES No. 7

Science Safety

Grades K-12

BUREAU OF CURRICULUM DEVELOPMENT
BOARD OF EDUCATION • CITY OF NEW YORK

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FOREWORD

This publication, the fourth revision of the original report by the Standing Committee on Science, is designed to acquaint teachers with the latest and best safety practices in science teaching.

Science educators should know the hazards involved in the handling and use of heat sources, glassware, high-voltage equipment, lasers, and cathode rays. They must also be alert to those dangers that might develop in the handling of potential explosives, flammable liquids, combustible substances, corrosive chemicals, radioisotopes, and oxidizing agents and substances that come in contact with water. Such safety expertise is a significant input of the science staff's teaching program.

Principals are requested to place copies of this report in the hands of all supervisors and teachers of science and laboratory specialists. It is suggested that *safety* be the subject of one or more science conferences each term.

In order to receive an official permit from the New York City Fire Department to store chemicals, acids, and flammables, principals are required to adhere to the rules and regulations described in the Department's F. P. Directive 8-59, dated September 25, 1959, which is reproduced in the appendix of this publication.

SEELIG LESTER
Deputy Superintendent of Schools

PREFACE

Teachers of science are in a unique position to help students learn to understand and appreciate the importance of safety for the protection of life and limb. From day to day, in the performance of demonstrations and in the conduct of laboratory experiments, science teachers can show how to anticipate and cope with the problems of safety in science investigations. By providing good examples of the right ways to set up and use materials, science teachers can establish a school environment in which safety awareness grows and becomes an integral part of the lives of students.

Science Safety: Grades K-12 describes the potential areas of danger that may be encountered in the study of science from the prekindergarten to grade twelve and the precautions that should be taken to guard against these dangers. The bulletin includes general directions and an alphabetical section of special precautions and specific hazards.

Each science educator should read this handbook carefully and make every effort to apply the safety principles to his own teaching. In that way we can be sure that our students will come to realize that safety is no accident.

HARRY MILGROM
Director of Science (Acting)

ACKNOWLEDGMENTS

Science Safety: Grades K-12 is a revision of the 1964 edition of *For Greater Safety in Science Teaching.*

Harry Milgrom, Acting Director of the Bureau of Science, directed the preparation of this edition with the cooperation of David A. Abramson, Acting Director of the Bureau of Curriculum Development.

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Note to Elementary School Teachers and Supervisors

There are specific safety suggestions in *Science: Grades K-2*, *Science: Grades 3-4*, *Science: Grade 5*, and *Science: Grade 6*. In addition, these teachers and supervisors should refer to the following items in this bulletin:

Page	*Items*
8	39, 40, 41
11	1, 2, 3, 4 ,5
12	6, 7, 8, 9, 10, 11
13	21, 22, 23, 24, 25
14	Aquarium tank
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22	Living things
27	Projects, students
28	Rockets
28	Rocks
29	Steam engine

GENERAL DIRECTIONS

For Assistant Principals

1. Conduct departmental conferences at the beginning of each term to review safety procedures with all members of the science staff — science teachers, laboratory specialists, and laboratory technicians.
2. Issue to each newly assigned science staff member a copy of this manual. A signed statement from each science staff member that he has read the safety manual should be filed each term.
3. At the beginning of each term, and immediately in case of emergency, notify the principal, in writing, of any hazards, such as
   a. Defective gas fixtures, electrical outlets, and connections.
   b. Seats, desks, and tables so defective that they may cause injury.
   c. Inadequate storage cabinets.
   d. Lack of fire blankets, extinguishers, and sand-filled fire pails.
   e. Uneven and defective floors.
   f. Defective locks and inadequate security of preparation and storage rooms.
4. As specified in Board of Education regulations, make sure that a first-aid cabinet is in each science laboratory, preparation room, and elsewhere where needed for emergencies, and that ample reserve stocks of first-aid material are provided. A copy of the American National Red Cross *First Aid Textbook* should be kept with each first-aid cabinet. It is desirable to post a laboratory emergency chart in each laboratory and preparation room.
5. Inspect first-aid cabinets and fire extinguishers each term.
6. Make certain that combustibles and dangerous materials, such as poisons, are kept securely locked in a metal cabinet.
7. All acids should be stored in a soapstone closet or in crocks, NEVER in ordinary closets or wooden cabinets.

8. Store large bottles of acids and bases on the floor.
9. Make sure that chemicals which react with each other are not stored in close proximity. Thus, glycerin and nitric acid, or potassium chlorate and organic compounds, should be separated.
10. Provide for proper ventilation and illumination of storage areas.
11. Establish procedures so that pupils do not have unsupervised access to chemicals in preparation rooms, closets, and stockrooms.
12. Prohibit the storage of cyanides, except potassium ferrocyanide and ferricyanide.
13. Make sure that storage cabinets for sodium, potassium, calcium, and calcium carbide exhibit this warning in bold, easily read letters:

In case of fire
DO NOT use water

14. DO NOT allow pupils to touch anything in cabinets in which dangerous materials are stored.
15. Have safety showers tested once a week.
16. Inspect chemical cabinets monthly to look for hazards; eliminate any hazard that is found. Record the date of each inspection.
17. Advise science staff members that tools and sharp-edged instruments should be kept in good condition and stored in locked cabinets. Students using this equipment should be under close supervision at all times.
18. Limit the number of pupils assigned to each laboratory squad so that they can be properly supervised. Except for biology squads, each laboratory specialist or technician should supervise no more than three pupils per period.
19. Acquaint all squad members with safety regulations at the beginning of their service. Secure a parental consent slip for each squad member.
20. Do not assign to the preparation room persons not licensed as laboratory specialists or as science teachers.
21. Do not permit teachers without a science license to use specialized science apparatus or chemicals.

22. Advise science staff members to try out each new laboratory experiment or demonstration prior to class use to verify that all materials and apparatus work properly and safely. Routine experiments and demonstrations should be checked periodically for safety hazards.

23. Inspect classrooms, preparation rooms, and storage rooms frequently to prevent the accumulation of materials that could lead to such safety hazards as the accumulation of glassware and chemicals on demonstration tables, exhibits or projects that overload shelves, and cluttered window sills. Science materials on shelves should not extend beyond the edge of the shelf.

24. See to it that a metal or earthenware waste jar, or a fireproof plastic container, is provided in every classroom where science experiments are performed. Such receptacles, not wastepaper baskets, should be used for broken glassware and chemical residues. The custodian should be instructed to empty receptacles daily.

25. Discard unlabeled, contaminated, and undesirable reagents.

26. Make sure that a fire extinguisher and fire blanket are included as auxiliary equipment when portable laboratory tables are sent to nonscience rooms. For convenience, these may be attached to the table.

27. See to it that all demonstrations, experiments, or projects dealing with atomic energy or radioactivity are performed in accordance with prescribed safety practices. (See Hazards and Precautions, pages 14-31.)

28. Comply with the rules and regulations of the New York City Fire Department F.P. Directive 8-59, September 25, 1959, concerning the maximum quantities of combustibles which may be stored in a school. Order only appropriate quantities. (See Appendix, page 36.)

29. Review periodically, with science staff members, the use of the various types of firefighting apparatus found in the science department. Practice how to remove from the wall and use a carbon dioxide extinguisher and a fire blanket. Obtain the cooperation of the school custodian in replenishing the extinguisher.

30. Order protective eye goggles or face shields and make sure that these protective devices are worn whenever necessary. (See General Circular No. 5, 1971-1972, page 41.)

For Science Teachers

1. Notify the science supervisor immediately of any hazard that comes to your attention.
2. Be familiar with first-aid treatment.
3. When an injury or accident occurs, give the permissible first aid and then
   a. Report accident immediately to the principal or his designated agent.
   b. Arrange for the completion and filing of the proper forms, signed by the injured party, witnesses, and the staff members concerned.
4. Perform classroom experiments and demonstrations only if you have previously tried them out or have been properly instructed by the supervisor or his representative.
5. Make sure that the room is properly ventilated and that there is no flame in the room. When using flammable, volatile liquids (such as chloroform or alcohol).
6. To prevent breakage store bottles of dangerous chemicals, such as acids and alkalies, on the floor in a protected area of the acid room or in the bottom of a steel cabinet.
7. NEVER add water to concentrated acid. To prepare a diluted acid, follow these steps:
   a. Start with water in a heat-resistant container.
   b. Stand the container in a sink filled with cold water.
   c. While stirring, slowly add small quantities of the concentrated acid to the water.
8. Take extra precautions with concentrated sulphuric acid, nitric acid, and glacial acetic acid, and with concentrated solutions of caustic alkalies and other corrosive chemicals, such as phenol, bromine, and iodine. (See Hazards and Precautions, pages 14-31.)
9. Avoid, if possible, the use of white phosphorus. DO NOT permit students to use white phosphorus.
10. Keep all types of combustible materials in metal cabinets or soapstone closets that can be locked. NEVER store these materials on laboratory tables or in classrooms.

11. Do not store sodium, potassium, calcium, or calcium carbide on shelves above vessels containing water. After the original containers of sodium and potassium have been opened, these metals must be stored immersed in kerosene. Alkali metals are corrosive and must not come in contact with the skin. Small pieces of sodium residue should be burned in the fume hood.
12. Examine carefully and test for safety hazards all devices or equipment brought in by pupils before demonstrating them to the class.
13. Observe the following precautions when performing experiments where there is a possibility of splintering and flying glass, a flash, or an explosion.
    a. Pupils must be kept not less than eight feet away from the demonstration table.
    b. Place a safety shield between the pupils and the demonstration. (See Approved Lists of Science Supplies.)
14. Keep all bottles and other containers tightly stoppered and labeled.
15. Do not return surplus chemicals to their containers.
16. Discard chemicals that are in unlabeled containers. Wipe up spills immediately.
17. Use minimal quantities of chemicals in demonstrations and experiments.
18. Do not place bottles containing acids or volatile organic liquids near heating pipes nor allow them to stand in the sun. Under such conditions, dangerous gas pressures may develop.
19. Provide individual straws or mouthpieces for pupils who are asked to blow into tubes, balloons, or plastic bags.
20. Use tongs to handle dry ice. Do not place dry ice in a closed container. The accumulation of CO_2 gas may lead to an explosion. A loose cotton plug may be placed in the opening.
21. Do not use ether in a room where there is flame or where flames may soon be used. Use only small quantities at a time. The room should be well ventilated. If possible, use ether near an open window. Allow containers in which ether has been used to air out thoroughly before being washed. Put ether-soaked cotton or rags in a fireproof receptacle. (See General Directions for Assistant Principals, No. 24.) Set receptacle aside in a safe place to evaporate. These directions also apply to other volatile substances, such as carbon disulfide, benzene, and acetone.

22. Observe the following precautions when inserting glass tubing, thistle tubes, or glass rods into rubber stoppers:
    a. The end of the glass tubing being inserted into the stopper should be fire polished.
    b. The glass tubing should easily fit the hole.
    c. Moisten the glass tubing and the hole with a lubricant, such as water, soap solution, glycerol, or petroleum.
    d. Use cloth or leather gloves to protect hands from injury in case the glass tubing breaks.
    e. Grasp the glass tubing very close to the rubber stopper.
    f. Position both hands so as to avoid injury if the glass should break.
    g. Insert the glass tubing through the hole in the stopper with a gentle twisting motion.

23. Observe the following precautions when removing glass tubing, thistle tubes, or glass rods from rubber stoppers:
    a. Discard glass tubing that is tightly frozen in rubber stoppers.
    b. Remove glass tubing from rubber stopper as soon as possible after use to prevent the glass from freezing to the stopper.
    c. Remove glass tubing which has frozen into a rubber stopper by using a lubricated cork borer that is just large enough to slip over the glass. Protect hands with cloth or gloves. Slowly twist the cork borer through the stopper to bore the frozen glass tubing out of the stopper.
    d. Special precautions should be observed if a pocket knife or single-edge razor blades must be used to split the stopper.

24. Try out a propane burner in the preparation room before using it in the classroom. Under no circumstances should pupils use a propane burner. Do not store excessive supplies of propane tanks. (See Special Circular No. 24, 1963-1964, page 14-31.)

25. Demonstrate pipette techniques. Arrange for pupils to practice these techniques with water. Do not pipette by mouth any radioactive materials, bacteriological cultures, polluted water, organic solvents, or other harmful substances. Instead, use a rubber bulb or a vacuum line. (See Hazards and Precautions, pages 14-31.)

26. Caution students who are to heat material in test tubes against looking down into the tube and against pointing the mouth of the tube toward themselves or others. Caution them to hold the test-

tube holder in a way that will prevent material that boils over from hitting their hands. Do not heat the holder.

27. Instruct pupils to slowly heat substances in the test tubes, shaking the tube carefully at the same time. Otherwise, vapor meeting a head of matter above it may cause the bottom of the tube to be blown out, or the matter to be ejected violently.

28. Use only heat-resistant glassware as containers in which to heat substances.

29. Instruct students in the proper use of Bunsen burners and alcohol lamps. Boys and girls with long hair should be given rubber bands to fasten their hair in pony-tail fashion to avoid the possibility of their hair igniting. Ties and loose clothing should be tucked in. When a Bunsen burner "strikes back" (burns at the spud), shut off the gas immediately and do not touch the hot barrel of the burner.

30. Instruct pupils to use appropriate protective devices, such as tongs, test-tube holders, and asbestos gloves, when heating objects. Warn them not to hold hot objects in their bare hands.

31. Ensure that protective eyewear is worn by pupils, teacher, and visitor when objects are heated. Goggles or other protective eyewear must be available for all personnel. Protective eyewear used by one class should be properly sterilized by a method approved by the Board of Health before being distributed to the next class. It is recommended that each student be provided with a pair of goggles for his personal use during the term. Contact lenses and regular eyeglasses are not substitutes for safety goggles. (See General Circular No. 5, 1971-1972, page 41.)

32. Use caution in applying heat to any plastic item because it may be flammable.

33. Familiarize yourself with the purposes and operation of the various kinds of fire extinguishers found in the science rooms. Do not direct a stream of water on oil or electrical fires; instead use the carbon dioxide extinguisher or sand.

34. Cover a sterno can with the lid to extinguish the flame. If the flame is to be re-ignited, take precautions in handling the hot lid and can.

35. Do not issue broken or cracked glassware.

36. Prepare all dangerous or flammable gases under a fume hood.

37. Observe the following precautions in experiments involving pupils' use of concentrated acid:
    a. Have available a battery jar filled with sodium bicarbonate solution or a paste made by adding sodium bicarbonate to a little water. Use the bicarbonate after the acid-burned area has been washed thoroughly.
    b. When possible, hydrochloric acid should be used in preference to sulfuric acid. The latter is more harmful to the skin.
    c. Concentrated acid should be dispensed only by the teacher.
    d. If acid is spilled on skin or clothing, instruct pupils to wash immediately with large quantities of water.

38. When using a solution of phosphorus in carbon disulfide to demonstrate spontaneous combustion, exert great caution to prevent fire and to avoid painful and dangerous skin burns from the phosphorus. The solution should be covered with a layer of water and kept in a small, glass-stoppered bottle. This bottle should be stored in a metal container. To obtain the solution, a medicine dropper is squeezed and inserted below the water into the solution. After use, the medicine dropper is contaminated with phosphorus and is a fire hazard. Store the dropper in the same metal can as the solution by attaching it to the bottle with a wire holder. Articles having phosphorus on the surface may be made more safe by covering them with a solution of copper sulfate. Phosphorus on the skin should be coated immediately with a copper sulfate solution until medical care can be obtained.

39. In grades K-5, the only acids to be used in experiments are vinegar and lemon juice. Bicarbonate of soda is the only base to be used.

40. In grades K-5, DO NOT demonstrate the model volcano in which ammonium bichromate and magnesium are used.

41. Except in chemistry classes, DO NOT permit pupils to taste or smell chemicals. The teacher may smell chemicals, only when absolutely necessary, by using his hand to waft the vapors toward his nose when the test tube is held at least six inches from his face.

42. In administering first aid, be guided by the following statement from *The Administration of Safety in New York City Schools* (Curriculum Bulletin No. 13, 1958-59 Series).

> In rendering first aid, the guiding principle is that the person is administering only immediate temporary care pending administration of competent medical care. . . .

First aid, according to the New York State Education Department Bulletin, *First Aid Care of School Emergencies,* is "treatment which will protect the life and comfort of the pupil until authorized treatment can be secured and is limited to *first treatment only,* following which the child is placed under the care of his parents upon whom rests the responsibility for subsequent treatment." . . . Procedures included in the American Red Cross official textbook should be followed.

Several especially relevant follow additional first-aid procedures:

a. *Burns from fires and chemicals.* For chemical burns, wash and flush area with water and remove any clothing or jewelry that may have been in contact with the chemicals. For burns caused by fire or hot objects, apply cold water until the pain subsides.

b. *Eye injuries from chemicals.* Quickly flush eye thoroughly with water for at least 15 minutes. Be sure the eyelids are kept open by holding them away from the eyeball. Remove contact lenses if present. In first-aid treatment of the eye, use water *only.* Summon medical attention, but do not interrupt the washing procedure. Eyecups should be available and should be used.

c. *Inhalation of gases.* If a student inhales a toxic gas, such as chlorine, hydrogen sulfide, sulfur dioxide, or nitric oxide, remove him to fresh air immediately.

d. *Ingested poisonous chemicals.* Read the label on the original container for specific first aid. In general, if the student is conscious, give him as much water as he can drink.

Acids (acetic, hydrofluoric, hydrochloric, nitric, sulfuric, phosphoric, phenol): If the acid is swallowed, give large amounts of milk of magnesia or aluminum hydroxide gel. Follow with large amounts of egg white obtained from the school kitchen. DO NOT INDUCE VOMITING. Do not give carbonates or sodium bicarbonate.

Bases, caustic alkalis (ammonium hydroxide, calcium oxide, sodium hydroxide, potassium hydroxide): DO NOT INDUCE VOMITING. Give large amounts of 1% acetic acid or vinegar (1 part of vinegar to 4 parts of water), 1% citric acid, or lemon juice. Follow with milk.

NOTE: A Poison Control Center, manned 24 hours a day, is maintained by New York City. The telephone number is 340-4494. Keep this number posted.

For Laboratory Specialists

1. Observe all precautions listed in the preceding sections of this manual.
2. Acquaint all squad members with safety rules and regulations at the beginning of their service.
3. In cooperation with the teacher, perform the actual procedures of each laboratory experiment or demonstration prior to the class session, to see that all materials and apparatus work properly.
4. Close the preparation room whenever it is not under the direct supervision of a laboratory specialist or science teacher.
5. Make sure that demonstrations, experiments, or projects dealing with atomic energy or radioactivity are performed in accordance with safety practices in that field.
6. Do not allow squad members to handle materials in cabinets reserved for dangerous substances.
7. Be fully acquainted with first-aid treatments.
8. Notify the supervisor of the existence or development of any hazard.
9. Keep all bottles labeled at all times. (If no other kind of label is available, a piece of adhesive tape will serve the purpose.
10. Never permit squad members or students working on projects to remain unsupervised in stockrooms or preparation rooms.
11. Know the hazards involved in the storage of scientific equipment and chemicals.
12. Employ approved safety standards and methods in the storage and use of all supplies.
13. Take approved safety precautions in the transportation of all equipment and supplies to and from the science classrooms and laboratories.
14. Advise teachers regarding safety precautions required for the proper use and manipulation of specialized equipment and supplies.
15. Inspect new equipment for hazards before approving payment.
16. Instruct squad members never to handle apparatus or chemicals unless they received specific instructions on their use.

17. Inspect pupil-made projects for safety hazards before these projects are demonstrated in the classroom.
18. Supervise, with great care, pupil use of tools and sharp-edged instruments.
19. Limit the number of pupils on the laboratory squad to a maximum of three per period. In biology, such squads may be somewhat larger.
20. Do not permit pupils to transport dangerous chemicals except under the direct supervision of a laboratory specialist.
21. Give permissible first aid when an injury or accident occurs, and then
    a. Report immediately any injury or accident to the supervisor of science.
    b. Arrange for the completion and filing of the accident report signed by the injured party, witnesses, and staff members concerned.

Pertaining to Pupils

1. Pupils in school must be under the direct supervision of a supervisor or his representative at all times, as required by the By-Laws of the Board of Education.
2. At the beginning of each term, instruct pupils in general safety precautions before they are allowed to work in the laboratory. Emphasize that safety is essential for all laboratory work.
3. Instruct pupils never to handle apparatus or chemicals in the laboratory until they have had specific instructions.
4. Instruct pupils to report at once anything in the laboratory that seems unusual or improper, such as broken, cracked, or jagged apparatus, and reactions that appear to be proceding in a peculiar manner.
5. Instruct pupils to immediately report to the teacher any personal injury (burn, scratch, cut, or corrosive liquid on skin or clothing) no matter how trivial it may appear.

6. Pupils must wear sensible clothing that cannot come in contact with science apparatus or chemicals. They also must either cover their hair or wear it in such a manner that it cannot contact chemicals or equipment.
7. Pupils should transport laboratory materials through the halls only during the intervals when classes are not passing.
8. Pupils may not transport dangerous chemicals, such as concentrated acids and bases.
9. Before working with sharp tools, pupils must demonstrate to the teacher that they are competent to use them.
10. Pupils should not taste chemicals or other unknown materials.
11. Pupils should be given specific safety instructions for each laboratory activity that presents a hazard.
12. Warn pupils that they may not use propane burners in laboratory experiments. (See Special Circular No. 24, 1963-1964, page 40.)
13. Show pupils how to pour liquids properly from a bottle without spilling.
14. Warn pupils NEVER to pour reagents back into bottles, or to exchange stoppers of bottles, or to place stoppers on the table.
15. Pupils may not dilute any concentrated acid or prepare a sodium hydroxide solution.
16. Caution pupils engaged in glass bending to allow the glass to cool on a piece of asbestos before further handling.
17. Caution pupils against grasping any electrical device which has just been used. Many electrical devices are hot after use and may cause serious burns.
18. Advise pupils that glass wool and steel wool should be handled carefully to avoid getting fragments into the skin. Where possible, use an appropriate grasping tool, such as tongs.
19. When a gas is collected by water displacement and a thistle tube is employed to add acid, caution pupils to make certain that the delivery tube is not clogged. Otherwise, the back pressure developed can force the acid up through the thistle tube and sputter the acid.
20. In any experiment in which gas is collected by water displacement, caution pupils to make sure that the generator is fastened securely.

The delivery tube should be removed from the water before the reaction is completed or the flame removed in order to prevent water from being forced back into the generator.

21. Caution pupils about the possible dangers from work done at home in connection with projects and science fairs. For example, dangerous chemicals that should be avoided or used *only* under direct supervision of a qualified adult are: hormones, carcinogens, radioactive isotopes, and explosives.

22. Caution pupils that, in or out of school, certain activities involving the use of chemicals are hazardous (e.g., setting fire to gasoline cans, breaking open fluorescent tubes, and throwing aerosol cans into a fire).

23. Advise pupils against experimenting with rocket fuels. FORBID their use in school. Many rocket fuels are explosives that may not be used legally within city limits.

24. Pupils should not use direct sunlight as a source of light for the microscope.

25. Students working on laboratory squads should receive specific instructions concerning the activities in which they may or may not engage. Caution them against the hazards of "fooling around." If supervision is not available, squad members must leave the preparation room. Squad members must submit parent consent slips. Squad members may not deliver concentrated acids or bases.

HAZARDS AND PRECAUTIONS

Alcohol lamp. Use on a nonflammable surface, well away from the edge of the table. Make sure that the cap is not so tight that pupils cannot readily remove it. Check to see that spilled alcohol is wiped up before the lamp is ignited. Take all precautions to make certain that the lamp does not tilt or leak.

Ammonia fountain. Use a thick-walled, round-bottomed flask to withstand differential pressure which develops.

Ammonium hydroxide. Open bottles of this concentrated reagent in a fume hood or well-ventilated area. Use bottles with rubber stoppers, rather than glass, to prevent seizing of the stoppers. Change the stoppers when necessary.

Aquarium tank. Tanks filled with water are very heavy. Empty tanks by using a siphon or dipper before moving them to avoid cracking the glass or sustaining muscle strain.

Autoclave. See pressure cooker, autoclave, sterilizer.

Blood. Do not ask pupils in lower grades to volunteer blood samples. Use a student donor for a drop of blood only if specific permission has been granted by the parent. Cleanse skin with 70% alcohol and use only a sterile disposable lancet. Do not use a lancet more than once. After drawing the sample, swab with alcohol and apply a band-aid or sterile gauze pad.

Boiling-point determination. Use tetrachloroethylene (boiling point, 121°C) for experiments performed by pupils. Formerly glacial acetic acid was used. However, the determination of the boiling point of glacial acetic acid may be performed under a hood only as a teacher demonstration.

Carbon disulfide. Keep in a tightly closed container, in a cool place, and remote from flames. Use a substitute reagent (such as tetrachloroethylene) where possible because CS_2 is toxic, volatile, and highly flammable.

Carbon tetrachloride. This reagent may NOT be used in the schools. Substitute the less toxic and nonflammable tetrachloroethylene (also known as perchloroethylene or "perk"). With proper ventilation, this is considered a safe substitute for carbon tetrachloride. It gives satisfactory results in the customary experiments with halogens.

CAUTION: Avoid having the vapors of any chlorinated hydrocarbon pass *against red hot metals* in order to prevent the formation of phosgene.

Cathode-ray tube. Use care in operating the oscilloscope. Only competent personnel should attempt to repair oscilloscopes or TV equipment. When making repairs, the equipment must first be disconnected from the 110-volt line. All high-voltage capacitors, including the picture-tube shielding, must then be discharged. Great care must be exercised in handling the picture tube because of the danger of implosion.

X-ray tubes may be displayed, but *not* used to generate X rays. Employ only those Crooke's tubes that are certified not to emit X rays at high voltages.

Centrifugal apparatus. Observe caution in using the Savart's wheel, siren disk, and centrifugal hoop. Make certain that the safety nut is securely fastened. Use the apparatus only at moderate speeds.

Centrifuge. Clamp the hand centrifuge securely to the table. In using the high-speed centrifuge, carefully balance the tube containing the specimen material with another tube containing water by using a platform balance to equalize the weight of the two tubes. Only use tubes designed for the centrifuge because these can withstand the great force that is generated.

Chromatography. Pupils should fill the narrow-bore tube with a solvent mixture by capillary action rather than by mouth.

Clinitest tablets. These tablets are used in testing for glucose. Do not permit students to hold them or to swallow them.

Copper sulfate. Wash hands thoroughly after using this chemical.

Crooke's tube. See cathode-ray tube.

Disinfectants. Phenol, carbolic acid, creosote, cresols, and lysol may cause burns of the skin and mucous membranes. Use rubber gloves.

Dissection. Issue clean, sharp instruments which are free of rust. Count the instruments issued and check the number returned before dismissing the class. Specimens preserved in formaldehyde should be thoroughly washed in running water before being used. Caution the pupils about the possibility of formaldehyde squirting out of a specimen, such as a frog, on the first incision into the abdomen. Caution pupils to avoid rubbing their eyes with their fingers after handling formaldehyde. Make provision for pupils to wash hands with soap and water after the dissection.

Electricity.

1. Teachers must check the wiring of electric circuits used by pupils before the switch is closed.
2. Pupils in grades K-8 should not connect circuits to wall outlets. They should use only dry cells. Discard dry cells that ooze. Pupils who touch the oozing chemicals should wash their hands thoroughly.
3. When dry cells are short-circuited, caution pupils to avoid burns from the hot connecting wire. Do not short-circuit storage batteries in grades K-6. Precautions should be taken to avoid accidental short circuits.
4. Teachers and pupils should use care in handling a storage battery. Despite its low voltage, the storage battery is a source of danger because of the acid it contains and because of the very high current which may flow because of a short circuit.
5. In removing an electric plug from its socket, pull the plug, not the electric cord.
6. Connect electric appliances to wall outlets, not to electric light sockets.
7. Inspect regularly all electric extension cords for defects in insulation and connections.
8. Do not use multiple plugs in electric wall outlets. A wall outlet should not be used for high-wattage electric apparatus (1500 watts or more). Motor-driven apparatus should not be connected to wall outlets unless such apparatus is essentially portable. Not more than 15 amperes should be drawn from a wall outlet. When several outlets on the same line are used, the total wattage should not exceed 1500 watts.

9. Electric devices should be electrically grounded.
10. In pupil experiments, limit the line voltage to a maximum of 30 volts. This does not apply to electrical laboratories or shops where students have special training and background, and where suitable precautions are taken.
11. Electric current used in the laboratory should be sent through a protective load resistance which is connected in series so as to limit the amount of current that will flow under any circumstance.
12. When working with an electric current, avoid bringing both hands in contact with live sections of the circuit. If possible, use but one hand at a time in all manipulations involving an electric circuit. Make changes only on dead circuits.
13. If electric current is constantly used near a grounded object, shield the object permanently with an insulating cover.
14. Caution students against the dangers of shock from contact with the terminals of a magneto or the secondary winding of an induction coil.
15. Mark clearly the high- and low-voltage connections of induction coils to prevent electrical shock.
16. In wiring an electric circuit, make the live connection the last step in assembling and the first step in disassembling.
17. In the handling of electrical equipment, such as radio, TV, and hot plate, observe the following precautions:
    a. Make certain that the current is off and a few minutes have elapsed before putting hands into the apparatus.
    b. Be sure that there is a "bleeder" (high resistance) across the output of the power supply. Otherwise, a severe shock from the charged capacitor may result.
    c. Caution pupils concerning the handling of B voltages in radio and TV sets. The high-voltage secondary is about 600 volts AC and the rectified B voltage is about 300 volts DC. Severe burns and shock can result from contact with these lines.
    d. Do not push any foreign objects into any piece of electric equipment, especially when it is connected to a source of electricity.

Electrolysis of water. Use a 1% solution of sodium sulfate as the electrolyte, not sulfuric acid. The hydrogen and oxygen formed at the top of the arms of the Hoffman apparatus should be transferred to small vials for testing. Do not ignite the hydrogen as it escapes from the stopcock. Use low-voltage direct current from storage batteries or from a low-voltage rectifier.

Epithelial cells. Direct pupils to secure epithelial cells by scraping the inside of the cheek carefully with a blunt edge of a flat toothpick. Do not use pointed instruments or any part of a scalpel. Pupils should break toothpicks and discard them after use to avoid reuse by another pupil.

Ester preparation. Use a water bath instead of a direct flame for heating the reagents. Avoid strong heat as it might cause splattering of the mixture which contains sulfuric acid.

Ether. The ether used as an anesthetic for laboratory animals and as a solvent is *diethyl* or *sulfuric* ether. This should not be confused with *petroleum* ether, a lightweight hydrocarbon, which is also used as a solvent. Diethyl ether should be ordered in one-pound tin cans. Prior to use, transfer the ether to a clean and dry, glass-stoppered, dark glass bottle. Iron wire or iron nails should be added to ethers to prevent the formation of explosive peroxides. Although this danger applies mainly to higher ethers, the precaution should also be used with diethyl ether. The bottle label must show the date on which the ether was transferred. After one year, any remaining ether must be discarded and the bottle carefully washed and dried before fresh ether is added.

CAUTION: Keep ether away from open flames!

Explosion. Use safety screens or shields when demonstrating explosions. Make glass vessels shatterproof by covering the glass with layers of scotch tape or by cementing cellophane to the glass. Use loosely stoppered test tubes when demonstrating the expansion of gases. When demonstrating rapid combustion with friction lid cans, use small cans located at least eight feet away from the nearest pupil.

Eyes. Protect the eyes with goggles or face shields when heating substances, especially when there is a danger of splattering. Do not rub the eyes after handling materials. Instruct pupils to direct the mouth of a test tube being heated away from themselves and from others. Caution pupils never to look directly into the sun but to

project the image of the sun on a wall or screen. Use special goggles when working with ultraviolet light or when viewing a carbon-arc source.

Extinguishers, fire. Pretest models of fire extinguishers (soda acid, CO_2, foamite) before demonstrating them. Use weak acids (vinegar) when demonstrating a model of the soda-acid fire extinguisher. Use a safety screen or shield, and have pupils move out of the front rows of seats to a safe distance from the demonstration table.

Field trip. Plan field trips carefully, taking into consideration student safety as well as the scientific and educational objectives. Among the precautions to be observed are the following:

1. Obtain parent consent slips.
2. Keep the students under your direct supervision at all times.
3. Instruct students to wear clothing and shoes that are appropriate for the locale, the activity, and the season.
4. Carry a first-aid kit.
5. Provide special instruction for students using specialized tools such as the geologist's hammer. Students should wear goggles when chipping rocks.
6. Identify poison ivy, poison sumac, and other local poisonous plants and animals for the students.
7. Warn students against drinking water from lakes, streams, and ponds and against eating wild berries, nuts, and fruits.
8. Caution pupils against picking up snakes in the field and against reaching into holes. They should exercise caution in turning over rocks and logs.
9. Plan ahead to provide the proper number of collection bags or bottles for specimens.
10. The leader should visit and examine the trip route in advance.

Gas bottles or cylinders. Read directions on container. Do not remove or deface the label. Store container in a cool place and away from laboratory flames. When using the cylinder, place it on a stand. Never tamper with any part of the cylinder valve. Use needle valves, connectors, and adaptors which have been specifically designed for the cylinder. Do not force connections or use homemade equipment. Close cylinder valves when not in use.

Close valves on empty cylinders and mark the cylinders empty. Never attempt to refill a cylinder. (All schools shall gather empty cylinders and hold them for pickup by vendor. Schools shall notify the vendor by letter when five (5) empty bottles are available for pickup.)

Glue. Many glues and cements contain volatile solvents which affect the nervous system. These should be stored where students do not have access to them. See *Prevention of Narcotics Addiction and Substance Abuse*. (Curriculum Bulletin No. 16, 1966-67). Some of these glues and cements also constitute a fire hazard when stored in large quantities.

Goggles. Consult the latest official directives concerning activities in the instructional program which require that protective eyewear must be worn by pupils, teachers, and visitors. The New York State Education Law requires the use of protective eyewear in shops and laboratories whenever objects are heated (See General Circular No. 5, 1971-1972, page 41). Potentially hazardous experiments and demonstrations should be performed only when all personnel are wearing protective eyewear such as goggles or face shields. Only use goggles that meet prescribed specifications. To prevent the spread of eye and skin infections, disinfect goggles each time they are transferred from one group to another.

Halogen preparation. Halogen gases are extremely poisonous and corrosive to the skin and mucous membranes. Avoid leakage of these gases and caution pupils against sniffing them as they emerge from the apparatus. Have available a bottle of dilute ammonium hydroxide; gently inhale its vapors to counteract the breathing of halogen fumes:

Only the teacher may demonstrate the preparation of chlorine. Use small quantities of reagents and provide good ventilation in the room. In preparing chlorine, heat gently or provide controlled heat by use of a water bath. Line up a bottle of sodium thiosulfate as the last bottle in the series. Quickly cover with glass plates the bottles in which reactions take place between chlorine and other substances. Chlorine should *not* be generated by adding concentrated hydrochloric acid to potassium chlorate. The products of this reaction are explosive.

In preparing bromine, avoid the escape of bromine vapors into the air by collecting it under the water. For experiments on the prop-

erties of bromine, use bromine water. Liquid bromine, if stored, should be kept in a glass-stoppered bottle sealed with paraffin or collodion. If bromine comes in contact with the skin, flush with water immediately.

CAUTION: Pupils are not to touch iodine crystals.

Hydraulic press. Do not use this apparatus to crush objects made of glass, ceramic, or wood. These materials may shatter dangerously under pressure.

Hydrochloric acid. The concentrated acid releases hydrogen chloride gas. Bottles of the concentrated acid should be opened in a hood or well-ventilated areas. Dilute the acid by adding it slowly to water and stirring.

Hydrogen chloride preparation. Prepare in a small, round-bottomed flash. Use only a few crystals of salt so that only small amounts of this irritating gas are generated.

Hydrogen experiments.

1. Never ignite hydrogen flowing from a generator until you are certain that there is no residual air in the generator. Air and hydrogen constitute an explosive mixture. Test to make sure that the gas is nonexplosive in the following manner:

   Take a sample of the evolving gas in a test tube which is held mouth down over the delivery tube and bring this test tube to a flame. If the gas is explosive there will be a slight pop and the hydrogen will not continue to burn. Continue this procedure until the gas collected in the test tube is nonexplosive. It will then burn quietly in the test tube and may then be used to ignite the hydrogen coming from the generator.

   Use a small generator, rather than a large one, to reduce the volume of residual air which must first be expelled. Use goggles and a protective screen. To prevent a flashback, place a fine copper screening inside the delivery tube.

2. When sodium is placed on water, use a small piece (half the size of a pea) to avoid violent burning and dangerous spattering. Use a large open vessel, such as a twelve-inch culture dish or a large crystallizing dish. Avoid contact of the sodium with the sides of the container. Potassium should not be used because the reaction of water with potassium is more violent.

Hypodermic syringe. The storage and use of hypodermic syringes is restricted by the State Education Department. Before syringes are purchased or used, refer to Special Circular No. 76, 1967-1968 (see page 42.) Follow the circular's instructions concerning storage, records, inspection, theft, and destruction.

Infrared apparatus. Do not direct infrared beams at students or teachers because of the danger of severe burns.

Jet action. Gas from carbon dioxide cartridges should be carefully released only by the teacher. If wire guides are set up for this demonstration, they should be securely fastened and pretested before use in the classroom.

Laser. Burns and eye injury may result from improper use of lasers. Lasers may be demonstrated only in high schools and only under the supervision of a science supervisor or his representative. Use only approved low-power lasers that operate with an output of 0.5 milliwatts per square centimeter (mw/cm^2) or less. All electric circuits should be housed in well-grounded cabinets and the capacitors should be shielded. To avoid injury, DO NOT look directly at the laser beam, wear goggles with approved glass, and stay out of the path of the initial and reflected beams. Caution students against experimenting with lasers at home.

Liquid air, liquid nitrogen, liquid oxygen. Containers of these substances should never be stoppered because they evaporate rapidly and explosive pressures may build up. A loose glass wool plug may be used.

Living things.

1. Marine and fresh water animals
   a. Caution students against tasting or eating any organism collected in the field.
   b. Caution students concerning the dangers of collecting and handling specimens with claws, spines, or poisonous secretions, such as the crayfish, Portuguese man-of-war, sea-urchin, and jellyfish. Some pupils may be hypersensitive to stings by aquatic organisms. Boots or sneakers should be worn when collecting specimens.
   c. Do not keep decaying organisms. Preserve or refrigerate dead specimens which are to be used over an extended period of time.

2. Land animals
   a. Provide instruction on the collection, care, and handling of animals that are kept in the school or which might be encountered in the field.
   b. Clean and disinfect animal cages. Inspect them for hazards, such as frayed wires or sharp edges.
   c. Pick up rat cages by the handle, not by holding the wire mesh. A rat can inflict a severe bite through the spaces of the usual wire mesh.
   d. Gloves should be worn when handling animals that may bite or scratch (e.g. rabbits, rats, hamsters).

3. Plants
   a. Caution pupils against tasting or eating mushrooms, berries, seeds, and other parts of plants.
   b. Before starting a field trip, provide advance identification of poison ivy, poison oak, and poison sumac if these are likely to be encountered. Caution students against contact with nettles, burrs, and thorns. Pupils should not wear shorts on trips that will take them through fields and woods. Sturdy footwear should be worn.
   c. In lessons on flowers and bread mold, take care to prevent the excessive distribution of pollen or spores. Some students may be allergic to these materials. Culture dishes containing bread mold should be covered with cellophane.
   d. Refer to item on Field Trips, page 19.

Mercury. Liquid mercury and its vapor are poisonous. Avoid inhaling the vapors produced when mercuric oxide is heated. DO NOT permit students to play with mercury droplets that are spilled or are released from broken thermometers, because mercury is readily absorbed through the intact skin. Do not permit mercury to accumulate in the sink trap. Clean up all spilled mercury and store in a stoppered bottle.

Microorganisms. Activities involving microorganisms constitute a valuable aspect of science instruction. However, the extent to which microorganisms can safely be used depends upon the age and prior training of the pupils, the competence of the instructor, the availability of appropriate apparatus, and the kind of organism studied. Precautions for handling microorganisms include the following:

1. Do not culture pathogenic organisms such as bacteria, algae, molds, protozoans, or viruses. Do not prepare a culture from a pupil's saliva or from his cough spray because this material may contain pathogens. Use only nonpathogenic stock cultures obtained from a reliable source. *Treat all bacterial cultures as if they are pathogenic* and use sterile techniques throughout.
2. Flame wire loops used for transferring bacteria before and after each use.
3. Strictly enforce rules against eating and drinking in the laboratory.
4. To clean exposed Petri dishes containing bacteria and agar, first soak them in a strong disinfectant such as lysol or 5% phenol. Then, using a wooden stick (such as a tongue depressor) and wearing rubber gloves, remove the agar film to a heavy layer of newspaper and give it to the custodian for disposal. Then wash the dishes in a cleansing agent or in soap and water and sterilize them in an oven for two hours at 160°-190°C. An alternative procedure is to sterilize the exposed Petri dishes in a pressure cooker and pour off the hot liquid agar. The use of sterile disposable plastic Petri dishes eliminates the foregoing procedures.
5. Pipettes used for transferring cultures, or for making dilutions, present a great potential hazard for untrained personnel. After use, pipettes should be placed into a cylinder containing disinfectant solution, washed in an automatic pipette washer, and then sterilized. To sterilize pipettes, place them in a sterilizing can; heat them for two hours in a hot-air oven at 160°-190°C. Keep pipettes in the sterilized can.
6. Use a bulb attachment, rather than direct mouth-pipetting, for all fluids except water or saline. Do not blow a fluid containing microorganisms out of the pipette because spattering may result.
7. Sterilize all contaminated material that is to be discarded.
8. Keep hands away from the face while working with microorganisms.
9. Seal with transparent tape any exposed Petri dishes which are passed around the class for inspection.

10. Do not permit a broth culture to wet the cotton plug or cap.
11. Do not permit fermentation to take place in a closed system or tightly sealed container.

Microtome. Keep fingers away from the blade while adjusting, cleaning, and using this instrument.

Neutralization. Have students use dilute acids and bases. Pupils should not taste the salt that is formed.

Nitric acid. The concentrated acid is extremely corrosive to tissues. It reacts with many metals to produce the toxic nitrogen dioxide. Store in a cool place.

Nitrogen and its compounds.

1. In preparing nitric acid, clamp the retort into position by using a cork collar about two-thirds of the way down the tubular portion of the retort.
2. Concentrated nitric acid is highly corrosive.
3. DO NOT permit students to prepare nitrous oxide.
4. DO NOT prepare nitrogen. Only use liquid nitrogen cylinders as a source of nitrogen.

Oxygen, laboratory preparation.

1. Use the hydrogen peroxide method for preparing oxygen. Oxygen may be safely prepared from a 3-6% solution of hydrogen peroxide which is dropped on either powdered manganese dioxide or pelleted activated charcoal. No heat is necessary.
2. Another method for preparing oxygen is to add water to sodium peroxide. In this method, observe the following precautions:
   a. Avoid contact of the skin with moist sodium peroxide.
   b. Make certain that no active sodium peroxide is left in contact with paper or any other easily ignitable substance. If paper is used for pouring the chemical into the generator, wash the paper thoroughly with water before discarding.
   c. Use a pyrex flask rather than a bottle as a generator.
   d. Distribute the sodium peroxide to the pupils in dry flasks, ready for use.

e. Carefully control the rate of reaction by using a dropping funnel for adding water.

f. Caution the pupils that the flask contains a caustic alkali after the reaction is completed.

3. When preparing oxygen from mercuric oxide as a teacher demonstration, avoid inhaling the mercuric oxide powder. Also, do not breathe the mercury vapor that is given off.

4. Provide good ventilation of the room when sulfur or phosphorous is burned in bottles of oxygen. Use a fume hood if available.

Phosphine. DO NOT permit pupils to prepare this gas. A teacher may demonstrate its preparation but the greatest care must be exercised throughout. The generator may explode if air gets into it. Phosphine is poisonous and must not be inhaled.

Photosynthesis demonstrations. Many of these demonstrations involve the heating of a leaf in hot alcohol to extract chlorophyll. Observe the following precautions:

1. Only use heat-resistant glassware.

2. Employ an electrical hot plate. NEVER use an open flame where alcohol vapor is present.

3. If an open flame is used to bring water to a boil in a large beaker, *shut off the flame* before pouring a small quantity of alcohol into a small beaker and submerging the leaf in the alcohol. Then place the small beaker into the large beaker of hot water. The hot water is at a sufficiently high temperature to bring the alcohol to its boiling point.

Potassium. See sodium and potassium.

Potassium chlorate. This chemical has been used in the preparation of oxygen by students. However, it is a strong oxidizing agent. As such, it may provide the basis for an explosion when mixed with a reducing agent, such as carbon, or even with organic residues in the glassware. Threfore, the use of potassium chlorate should be avoided. Students should prepare oxygen from a 3-6% solution of hydrogen peroxide with manganese dioxide as a catalyst.

Pressure cooker, autoclave, sterilizer. In general these should be operated only by teachers and laboratory specialists. Pupils should

receive special instruction before being permitted to use these pieces of apparatus. Precautions for use of this equipment include the following:

1. Before using the pressure cooker, autoclave, or sterilizer, become familiar with the manufacturer's specific instructions.
2. Examine the pressure release valve before using the apparatus and make sure the valve is in working order.
3. Do not allow the pressure to go above 20 pounds per square inch.
4. Allow the apparatus to cool before removing the cover. Pressure should be down to normal and the stopcock should be open before the clamps are released.
5. Place a protective screen around hospital-type autoclaves which are in permanent locations.
6. Place a warning sign on the autoclave when it is in use.

Projects, student. Provide group and individual guidance to pupils who are engaged in home or school projects to preclude the use of dangerous chemicals and microorganisms, faulty or dangerous equipment, or hazardous procedures. Examine carefully for safety hazards all student projects or demonstrations before permitting their display. Notify the parents if you know about a hazardous home experiment being conducted by a pupil.

Discourage experimentation with rocket fuels. Notify pupils that some fuels are explosives and may not be used legally within city limits.

Pupils should not prepare bacteriological cultures at home. When pupils perform home dissections for science-fair projects, caution them against sealing containers of decaying materials.

On 110-volt circuits, pupils should use properly mounted 110-volt toggle or push-button type switches, not knife switches. A fuse must be in series with the source of electricity.

Propane burner. Propane burners may not be used by students for experiments. They may be used by custodians and teachers, and by individual students only under the direct supervision of the science supervisor or his representative. See Special Circular No. 24, 1963-64 (page 40) for further information concerning the use of propane burners in the schools.

Protein food test. After adding the nitric acid in the xanthoproteic B-13 test for proteins, do *not* heat the materials. Rinse the test tube and its contents with water before adding ammonium hydroxide. Pupils should never handle a test tube or bottle containing concentrated nitric acid. The Biuret reagent used in testing for protein contains concentrated potassium hydroxide and should be handled with the usual precautions for strong alkalies. See related instructions for sulfuric acid and sodium hydroxide.

Radioisotopes. Materials should be ordered from chemical supply houses in small, unlicensed quantities and used in class with proper safeguards. Experiments with radioiodine (I^{131}) and radiophosphorus (P^{32}) and the precautions to be observed are outlined in *Laboratory Experiments with Radioisotopes for High School Science Demonstrations*. Caution pupils against keeping samples of radioactive ore at home. Do not permit pupils to handle radioisotopes except under direct supervision.

Information on radiation is also provided in the following: New York City Health Code, Article 75 on Radiological Hazards; and *Safe Handling of Radioactive Materials*.

Rockets. The launching of rockets containing explosive combustible mixtures is not only unsafe, but also illegal within city limits. If a rocket containing an explosive combustible mixture is brought to school, confiscate the rocket and notify the pupil's parents to promptly remove the rocket from the school. (See also, projects, student.)

Rocks. Rock fragments resulting from the chipping or crushing of rocks can cause serious eye injuries. Wear goggles when breaking rocks. Move pupils from the first two rows and use a safety shield. Pulverize rocks in a cloth bag.

Soapmaking. This process involves a hot solution of sodium hydroxide. Use gentle heat and stir cautiously. Wear goggles and gloves. If pupils test the manufactured soap for lather by rubbing it between the hands, they should wash their hands thoroughly with water because some sodium hydroxide may still be present in the soap.

Sodium and potassium. After the original container has been opened, these metals must be kept immersed in mineral oil or kerosene. If the metal is not to be used again for a considerable length of time, it should be imbedded in paraffin for storage.

Sodium hydroxide (lye). This substance is extremely corrosive in solid form or in concentrated solution. Considerable heat is generated when the solid is dissolved. Solutions should be prepared in heat-resistant glassware in a cold water bath. Use rubber stoppers on reagent bottles, as glass stoppers are likely to seize when used on bottles of sodium hydroxide solution.

Steam. Before generating steam, check the apparatus to ensure that excessive pressures cannot develop. Before each use, check safety valves on commercial apparatus, such as the model steam engine or pressure cooker, in accordance with the manufacturer's instructions. When generating steam in a test tube or flask, do not insert stopper tightly or wire down the stopper. In using hypsometers, caution pupils to direct outlets for steam away from their own and other students' eyes. In experiments involving the use of two valves, one of them must always be kept open.

Steam engine. To avoid explosions, make sure that excess steam pressure does not build up. Check safety valves manually to determine if they work. Maintain the proper water level in the boilers.

Sterilizer. See pressure cooker, autoclave, sterilizer.

Sucrose dehydration. When concentrated sulfuric acid is added to sucrose, make sure that the room is well ventilated before starting the demonstration. Use a 50 ml, or smaller, heat-resistant beaker. Do not permit pupils to handle the carbon residue because the occluded acid may cause burns. Place the beaker containing the carbon into a large beaker of water. When the residual acid in the carbon residue has been thoroughly diluted, discard the carbon into a stone crock.

Sulfuric acid. The concentrated reagent is very corrosive. It chars substances by extracting water from them. Much heat is generated in diluting the concentrated acid. Start with water in a heat resistant container. *Add the acid slowly to the water*, stirring constantly, to prevent spattering from excessive heat. NEVER add water to the concentrated acid. It is desirable to keep the container in cold water during this procedure.

Sulfur dioxide preparation. The collection of this gas should be done in a well-ventilated room or in a fume hood. Caution pupils against inhaling the gas. This preparation should be done only in a heat-resistant container.

Thermite. Have several rows of seats in front of the demonstration table vacated. Place a bucket of sand under the cup. Be very careful in approaching a mixture that has apparently failed to ignite because the mixture may flare up suddenly. The teacher should wear goggles and use a safety shield to protect the students.

Thermometer. Avoid breaking thermometers by exceeding their temperature range. Do not use thermometers as stirring rods. Do not permit pupils to collect mercury from broken thermometers. To insert a thermometer into a cork or rubber stopper use the same precautions as for thistle tubes and glass tubes. To remove a thermometer from a rubber stopper, use a wet, cork borer just large enough to slip over the thermometer. Then slowly work the cork borer through the stopper. An alternate method is to slit the stopper with a sharp knife.

Thermos bottle. When you demonstrate the double-walled glass insert, cover it with transparent tape to reduce the danger of flying glass if the insert should break.

Tools. Cut sheet metal only with sharp shears. Smooth the edges with a file or emery cloth.

Place hot soldering irons on stands to prevent fires. Use pliers to hold wires for soldering. Do not inhale fumes from solder paste.

Use only tools which are appropriate for the job to be done. For example, do not use knife or scissors blades for prying, as they may snap.

Ultraviolet light. Pupils may be momentarily exposed to this radiation as they observe its reflection from minerals, ores, teeth, and paints. However, prolonged exposure can cause serious burns of the retina. Pupils should not look directly at the light source. For activities requiring more prolonged exposure, such as in the observation of UV fluorescence from chromatograms of chloroplast pigments, use goggles which are appropriate for the wavelength of the UV light used. Ordinary eyeglasses provide some protection against UV light.

Vacuum experiments. Use heavy-walled, round-bottomed flasks or apparatus specially designed for vacuum work to prevent implosions. Use a safety shield.

Volatile compounds. Work with volatile reagents, such as benzene, ether and acetone in a well-ventilated room, or under a fume hood, to prevent fires, explosions and harmful inhalation. Store away from heat sources and sunlight. DO NOT dispose them by pouring down the drain as accumulated vapors may cause an explosion!

X rays. Do not operate or permit students to operate X-ray tubes or cathode-ray tubes or other devices that may be potential X-ray emitters at high voltage.

APPENDIX

CHEMICALS DEEMED HAZARDOUS (By Fire Department)

Explosives

Chapter 19 of the Administrative Code of the City of New York defines an explosive as a compound or substance having properties of such a character that alone or in combination with other substances may decompose suddenly or generate heat or gas or pressure to produce flames or destructive blow to surrounding objects.

Item	*Container and Restrictions*
Picric Acid	g.s.b.*
Carbon Disulphide	g.s.b.
Collodions	g.s.b.
All gases under pressure	steel container

Flammable Liquids

Flammable liquid is any liquid that will generate flammable vapors at a temperature below 100°F.

Item	*Container and Restrictions*
Crude Petroleum	tin can
Benzine, Benzol, or Naphtha of any kind	tin can
Coal Tar	tin can
Coal Tar Oils (heavy)	tin can
Wood Creosote	g.s.b.
Ether, Ethyl	tin can
Varnishes, Lacquers, etc.	tin can
Acetone	g.s.b.
Alcohol, Ethyl	tin can
Alcohol, Denatured	tin can

* g.s.b. means glass stoppered bottle, or plastic screw cap.

Item	*Container and Restrictions*
Alcohol, Methyl	tin can
Aldehyde, Ethyl	g.s.b.
Amyl Acetate	g.s.b.
Amyl Alcohol	g.s.b.
Aniline Oil	g.s.b.
Kerosene	tin can or g.s.b.
Nitrobenzol	tin can
Turpentine	tin can
Toluol	tin can
Xylol	tin can
Essential Oils	g.s.b.
Glycerine	g.s.b.

Combustible Substances

Combustible substances are compounds or mixtures that emit flammable vapors at a temperature of 100°F to 300°F.

Item	*Container and Restrictions*
Phosphorus, white	immersed in water in a glass bottle surrounded by sand
Phosphorus, red	g.s.b.
Sulphur	tin can
Metallic Magnesium, including strip and powder	g.s.b.
Camphor	g.s.b.
Rosin	g.s.b.
Pitch (coal tar pitch)	tin can
Tar, refined (wood)	tin can
Venice Turpentine	g.s.b.
Burgundy Pitch	g.s.b.
Naphthalene	g.s.b.
Shellac	g.s.b. or tin can
Resin, Balsam, and other varnish gums	tin can
Pulverized Charcoal	tin can
Lampblack	tin can
Cotton, absorbent	paper box
Cotton Batting	paper box
Lycopodium	g.s.b.
Zinc Dust	g.s.b.

Dangerously Corrosive Chemicals

Item	*Container and Restrictions*
Anhydrous Acetic Acid	g.s.b.
Glacial Acetic Acid	g.s.b.
Hydrofluoric Acid	wax bottle in an outside container of kaolin
Hydrochloric Acid	g.s.b., 6 lbs. each bottle
Sulphuric Acid	g.s.b., 9 lbs. each bottle
Phenol (Carbolic Acid)	g.s.b.
Sodium Hydroxide	g.s.b.
Potassium Hydroxide	g.s.b.
Acid, Chromic	g.s.b.
Acid, Nitric	g.s.b.
Acid, Nitric, Fuming	g.s.b.

Peroxides and Other Oxidizing Agents

Item	*Container and Restrictions*
Hydrogen Peroxide, US.P.	g.s.b.
Sodium Peroxide	tin box
Potassium Peroxide	g.s.b.
Calcium Peroxide	g.s.b.
Barium Peroxide	g.s.b.
Other Hydrogen Peroxides over 3%; not to exceed 30%	g.s.b. (Keep sealed in original container with asbestos fiber packing, away from heat and sunlight.)
Potassium Chlorate	g.s.b. or tin can
Sodium Chlorate	g.s.b. or tin can
Barium Chlorate	g.s.b.
Other Metallic Chlorates	g.s.b.
Potassium Permanganates	g.s.b.
Sodium Permanganate	g.s.b.
Other Metallic Permanganate	g.s.b.
Bismuth Subnitrate	g.s.b.
Barium Nitrate	g.s.b.
Strontium Nitrate	g.s.b.
Cobalt Nitrate	g.s.b.
Iron Nitrate, Ferric	g.s.b.
Mercury Nitrate (mercuric)	g.s.b.

Item	*Container and Restrictions*
Mercury Nitrate (mercurous)	g.s.b.
Potassium Nitrate	g.s.b. or tin can
Silver Nitrate	g.s.b. (Use brown bottle.)
Sodium Nitrate	g.s.b. or tin can
Other Metallic Nitrates	g.s.b.

Substances Made Dangerous by Contact with Water

Item	*Container and Restrictions*
Calcium Carbide	g.s.b.
Metallic Potassium	immersed in kerosene in bottle surrounded by sand
Metallic Sodium	immersed in kerosene in bottle surrounded by sand
Quicklime	tin can
Sulfuric Acid	g.s.b.

NEW YORK CITY FIRE DEPARTMENT F.P. DIRECTIVE 8-59

(September 25, 1959)

RULES AND REGULATIONS RELATING TO THE STORAGE AND USE OF LIMITED QUANTITIES OF CHEMICALS, ACIDS, FLAMMABLES, ETC., FOR INSTRUCTION PURPOSES IN PUBLIC HIGH SCHOOLS (Filed with City Clerk, August 21, 1959)

(a) That no liquefied chlorine may be stored in any school;

(b) That no more than five (5) gallons of volatile flammable oils derived from petroleum, shale oil or coal tar should be stored at any one time;

(c) That no more than twenty-five (25) pounds of potassium and/or sodium chlorate is permitted to be stored;

(d) That no chemicals or substances as listed under C19-139.0 and C19-133.0 of the Code should be stored in a school;

(e) That it shall be unlawful to store chemicals in close proximity to each other when they are of an explosive nature, or when one increases the energy of decomposition of the other, or when they are so constituted that they may react upon one another and become explosive or flammable;

(f) That the storage of acids in containers should be confined to either the lowest shelves of soapstone cabinet, or within crockery or earthenware containers, so as to prevent spillage;

(g) That safety cans be provided for the storage of volatile flammable oils;

(h) That a bucket filled with sodium bicarbonate or soda ash be provided near storage of acids;

(i) That the storage of dangerous chemicals, volatile flammable oils and liquids be confined to metal cabinets vented at top and bottom. A card holder should be provided for a visible record of the contents and maximum amount stored therein; also, a caution sign, if applicable to read: "In case of fire do not use water";

(j) All preparation-, storage- and class-rooms should be provided with portable fire extinguishers of a type suitable for chemical fires. Same should be examined frequently to make sure that they have not been tampered with or removed from their designated places, and at least

once yearly all such devices must be examined for deterioration or injuries due to misuse, and recharged. The date of charging and signature of the person who performed it should appear on the tag attached to each extinguisher;

(k) Schools which use large quantities of dangerous chemicals, acids and/or flammable oils or liquids are not included in these regulations and applications for permits from such school should require special investigation by the Fire Department.

Note: The foregoing rules shall be the basis for the issuance of Fire Department permits to schools throughout the City of New York.

(l) Listed on the following page are the maximum quantities of combustibles and dangerous chemicals which may be stored in Public High Schools:

Maximum Quantities of Combustibles and Dangerous Chemicals Which May Be Stored in Schools

Explosives

Picric Acid	1 lb.	Sulphur Dioxide	1 lb.
Carbon Disulphide	10 lbs.	Nitrous Oxide	1 lb.
Carbon Dioxide	1 lb.	Oxygen	1 lb.
Anhydrous Ammonia	1 lb.		

Volatile Flammable Liquids (Insoluble)

Crude Petroleum	2 lbs.	Ether, Sulphuric	10 lbs.
Benzine, Benzola, or Naphthas of any kind	2 lbs.	Varnishes, Lacquers, etc.	2 lbs.

Volatile Flammable Liquids (Soluble)

Acetone	1 lb.	Alcohol, Methyl	5 gals.
Alcohol, Denatured	5 gals.		

Nonvolatile Flammable Liquids (Insoluble)

Amyl Acetate	2 lbs.	Turpentine	½ gal.
Amyl Alcohol	2 lbs.	Tolluol	1 gal.
Aniline Oil	1 lb.	Xylol	1 gal.
Kerosene	2 lbs.	Essential Oils	2 lbs.

Nonvolatile Flammable Liquids (Soluble)

Glycerine	5 lbs.

Combustible Solids

Phosphorus	¼ lb.	Sulphur	15 lbs.
Phosphorus, red	5 lbs.	Metallic Magnesium	1 lb.

Gums, Resins, Pitch, etc.

Camphor	1 lb.	Naphthalene	1 lb.
Resin	1 lb.	Shellac	1 lb.
Venice Turpentine	1 lb.		

Combustible Fibres and Powders (Vegetable)

Pulverized Charcoal	5 lbs.	Cotton, Absorbent	5 lbs.
Lampblack	2 lbs.	Lycopodium	1 lb.

Dangerously Corrosive Acids

Glacial Acetic Acid	5 gals.	Sulphuric Acid	12 gals.
Hydrofluoric Acid	1 lb.	Carbolic Acid	1 lb.
Hydrochloric Acid	12 gals.		

Acid

Acid, Chromic	1 lb.	Acid, Nitric	12 gals.

Peroxides

Hydrogen Peroxide, U.S.P.	10 lbs.	Other Hydrogen Peroxides over 3%, not to exceed 15%	5 lbs.
Sodium Peroxide	2 lbs.		
Barium Peroxide	2 lbs.		

Permanganates

Potassium Permanganate	1 lb.

Metallic Oxides

Lead Oxide (red)	5 lbs.	Oxide of Mercury; yellow precipitate (mercurous)	5 lbs.
Lead Oxide (Litharge)	10 lbs.		
Oxide of Mercury; red precipitate (mercuric)	10 lbs.		

Nitrates

Barium Nitrate	1 lb.	Mercury Nitrate (mercurous)	1 lb.
Strontium Nitrate	1 lb.	Potassium Nitrate	10 lbs.
Cobalt Nitrate	1 lb.	Silver Nitrate	5 lbs.
Copper Nitrate	1 lb.	Sodium Nitrate	15 lbs.
Iron Nitrate, Ferric Mercury Nitrate (mercuric)	1 lb.	Other Metallic Nitrates	5 lbs.

Chlorates

Potassium Chlorate	15 lbs.

Substances Made Dangerous by Contact with Other Substances

Calcium Carbide	5 lbs.	Metallic Sodium	½ lb.
Metallic Potassium	½ lb.	Zinc Dust	5 lbs.
All Other Metals of the Alkalies or Alkaline Earths	2 lbs.	Slaked Lime	25 lbs.

Special Circular No. 24, 1963-1964 (November 25, 1963)

USE OF PROPANE BURNERS IN THE SCHOOLS

This circular modifies the joint Academic and Junior High School circulars to the Principals issued on May 10, 1963. In that circular the principals were advised that the Fire Department of the City of New York had issued a regulation forbidding the use of Propane Burners in the science classrooms and laboratories in our schools.

On October 29, 1963 a hearing, requested by the Bernzomatic Corporation, the distributors of propane gas, was held before the Board of Standards and Appeals of the City of New York. As a result of this hearing the previous ruling of the Fire Department was modified as follows:

> "RESOLVED, that the decision of the Fire Commissioner, dated June 11, 1963, be and it is hereby modified and that the appeal be and it hereby is *granted* to permit the use of one pound cylinders of Bernzomatic propane in school laboratories, classrooms and workshops, *on condition* that the cylinders shall be identical with the sample submitted to the Board; *on further condition* that in school laboratories, classrooms and shops the cylinders shall be used only by custodians, teachers and students under the direct supervision of teachers; that they shall be used only on surfaces which are non-flammable; that at any one time the number of cylinders in a building shall be limited to two cartons, each containing 12 cylinders; that the storage shall be in metal cabinets which are louvred, kept locked and properly labeled."

Please be advised that propane burners should not be used by students for laboratory experiments. They may be used by custodians, teachers or by individual students only under direct supervision of teachers. Care should be taken to use the propane burners on non-flammable surfaces only. It will also be necessary to store the cylinders containing propane in locked metal cabinets.

General Circular No. 5, 1971-1972

Item 8. EYE PROTECTION IN SHOPS, LABORATORIES AND EXPERIMENTAL PROGRAMS

. . . In February 1971 the New York State Board of Regents amended the Regulations of the Commissioner of Education that pertain to eye safety devices (Section 141.8 Part 141). Your attention is directed to the revised section which requires that provision be made for the wearing of goggles by all *pupils, teachers,* and *visitors* observing or engaging in activities which involve:

Hot solids, liquids, or molten metal; milling, sawing, turning, shaping, cutting, or stamping any solid materials

Heat treatment, tempering, or kiln firing of any metal or other materials

Gas or electric arc welding

Repairing or servicing of any vehicle

Caustic or explosive chemicals or materials

Eye safety devices within the meaning of this regulation shall include face shields, goggles, safety glasses, welding helmets, hoods, and other specialized equipment. Such devices must meet the code of USA Standard Practice for Occupational and Educational Eye and Face Protection (Z87 standard, page 29) that was promulgated in October 1969 by the American National Standards Institute, Inc., 1430 Broadway, New York 10018.

It is important that teachers involved in the above categories see to it that children under their instruction use the goggles provided for them in all of the listed processes and *any other activities* that might create a hazardous condition for their eyes.

Eye protective devices, such as those listed by the Bureau of Supplies, are acceptable under this regulation.

Special Circular No. 76, 1967-1968 (March 21, 1968)

EDUCATIONAL USE OF HYPODERMIC SYRINGES AND NEEDLES

[Rules and regulations of the Board of Regents of the New York State Education Department give the procedures listed below.]

1. *Authorized Use of Hypodermic Syringes and Needles*

   Such use is limited to actual educational demonstrations or other educational purposes suggested and/or required in approved science courses of study.

   Each principal shall designate a specific person or persons on his staff who will be responsible for supervising the use of hypodermic syringes and needles. A record of his designation(s) should be filed with the District Assistant Superintendent and with the Director of Science.

   The person(s) so designated shall be responsible for safeguards, supervision and maintenance of records of purchases, use, storage and disposition of all hypodermic syringes and needles in the school.

   Any change in designated personnel shall be reported within 30 days to the Department(s) of Education and Health, with a copy to the District Assistant Superintendent and the Director of Science.

2. *Storage*

   Unused sticks of hypodermic syringes and needles shall be kept in double locked cabinets or rooms, under protection of suitable locks and keys. Cabinets shall be stationary. In no instance shall spring or combination dial locks be employed.

3. *Records*

   A record of all purchases of hypodermic syringes and needles shall be maintained. A running inventory must be kept indicating type, size and number of each item purchased, distribution made, balance on hand and date of receipt or disposition. A similar record of all items destroyed and dates of destruction must also be kept. A record of all hypodermic syringes and needles lost or stolen with appropriate dates must be reported immediately to the Department(s) of Education and Health, with a copy to the District Assistant Superintendent and the Director of Science.

An annual physical inventory must be taken each June 30 and entered in the running inventory record. All prescribed records shall be kept for a period of two years.

4. *Destruction of Hypodermic Syringes and Needles*

All hypodermic syringes and needles which are no longer usable or required shall be destroyed as follows:

Disposable hypodermic units shall have the needle detached from the syringe prior to disposal. All hypodermic syringes shall be crushed, broken or incinerated and all hypodermic needles shall be bent prior to disposal.

5. *Inspection*

All records and stocks of hypodermic syringes and needles maintained by schools and other educational institutions shall be readily available for inspection by the State Department of Health.

ARTICLES AND PUBLICATIONS ON SAFETY

"Accident Prevention — Its Management in the Schools." *The Science Teacher*, April 1967.

Administration of Safety in the New York City Schools. Curriculum Bulletin No. 13, 1958-59 Series. New York Board of Education of the City of New York, 1960.

Chemical Safety Guides. Washington, D.C.: Manufacturing Chemists Association.

First Aid and Care of Small Animals. New York: Animal Welfare Institute, 1955.

First Aid Manual. Chicago: American Medical Association, 1952.

"Guide to Laboratory Safety." *Laboratory World Magazine* (reprint). Los Angeles: Sidale Publishing Co. (2525 West 8 Street, Los Angeles, Calif. 90057).

Joseph, Alexander, and others. *Sourcebook for the Physical Sciences*. New York: Harcourt, Brace and World, 1961.

Manual of Laboratory Safety. New York: Fisher Scientific Co.

Morholt, Evelyn, and others. *Sourcebook for the Biological Sciences*. New York: Harcourt, Brace, 1958.

National Bureau of Standards. *Safe Handling of Radioactive Materials*. Handbook 92. Washington, D.C.: Government Printing Office, 1964.

Radiation Protection in Educational Institutions. Report No. 32. Washington, D.C.: National Council on Radiation Protection and Measurements, 1966.

Safety in Handling Hazardous Chemicals. East Rutherford, N. J.: Matheson Coleman & Bell, 1968.

"Safety in Science." *Science and Children*, March 1968.

Safety Publications. Washington, D.C.: American National Red Cross.

Steere, Norman V., ed. Handbook of Chemical Safety. Cleveland: Chemical Rubber Co., 1967.

U.S. Atomic Energy Commission. *Laboratory Experiments with Radioisotopes for High School Science Demonstrations*. Washington, D. C.: Government Printing Office, 1958.

ORGANIZATIONS CONCERNED WITH SAFETY

American Chemical Society
1155 Sixteenth Street, N.W.
Washington, D.C. 20036

American Society for the
Prevention of Cruelty to
Animals
441 East 92 Street
New York, New York 10028

Animal Welfare Institute
P.O. Box 3492
Grand Central Station
New York, New York 10017

Manufacturing Chemists
Association
1825 Connecticut Avenue, N.W.
Washington, D.C. 20009

National Association of Rocketry
1239 Vermont Avenue, N.W.
Washington, D.C. 20005

National Commission on Safety
Education
National Education Association
1201 Sixteenth Street, N.W.
Washington, D.C. 20036

National Council on Radiation
Protection and Measurements
4201 Connecticut Avenue, N.W.
Washington, D.C. 20008

National Fire Protection
Association
60 Batterymarch Street
Boston, Massachusetts 02110

National Safety Council
425 North Michigan Avenue
Chicago, Illinois 60611

National Science Teachers
Association
1201 Sixteenth Street, N.W.
Washington, D.C. 20036

National Society for Medical
Research
1330 Massachusetts Ave., N.W.
Washington, D.C. 20005

Safety Committee Council of
State Science Supervisors
c/o Franklin D. Kizer,
Science Supervisor
State Board of Education
Richmond, Virginia 23216

Underwriters Laboratories, Inc.
207 East Ohio Street
Chicago, Illinois 60611